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NEAR-SURFACE TEMPERATURE GRADIENTS AND THEIR EFFECTS ON THERMAL-INFRARED EMISSION SPECTRA OF PARTICULATE PLANETARY SURFACES; B.G. Henderson* and B.M. Jakosky**, Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO 80309-0392 (* also Department of APAS, ** also Department of Geological Sciences).

Introduction: The infrared energy emitted from a planetary surface is generated within a finite depth determined by the material's absorption skin depth. This parameter varies significantly with wavelength in the infrared but has an average value of around 50 μm for most geologic materials. In solid rock, heat transfer is efficient enough so that this 50 μm zone of the near surface from which the radiation emanates will be more or less isothermal. In particulate materials, however, heat transfer is more complicated and occurs via a combination of mechanisms, including solid conduction within grains and across grain contacts, conduction through the interstitial gas, and thermal radiation within individual particles and across the void spaces in between grains [1]. On planets with substantial atmospheres, the gas component dominates the heat transfer and tends to mitigate near-surface thermal gradients. However, on airless bodies, the gas component is absent and heat transfer occurs via solid conduction and radiation. If the particles are small relative to the average absorption skin depth, then the top 50 - 100 μm or so of the surface will be cooled by radiation to space allowing the creation of significant near-surface thermal gradients. In those regions of the spectrum where the absorption coefficient is low, the emission will come from the deeper, warmer parts of the medium, whereas in regions of high absorption, the emission will emanate from shallower, cooler parts of the medium. The resulting emission spectrum will show non-compositional features as a result of the thermal structure in the material.

We have modeled the heat transfer in a particulate medium in order to determine the magnitude of near-surface thermal gradients for surfaces on airless bodies and on Mars. We use the calculated thermal structure to determine the effects it has on the infrared emission spectrum of the surface.

Model Description: We have constructed a layered thermal model to calculate the heat exchange within a particulate planetary surface. At present, our model treats the medium as a homogeneous material in which heat is transferred between layers via conduction (solid and gas components) and radiation (radiative component).

We have assumed that the medium is purely emitting and absorbing (no scattering) which would be the case for a material consisting of particles very small relative to the wavelength of emission. Layer opacities at each wavelength are calculated by scaling the optical constants to the appropriate density using the Rayleigh scaling law [2]. The model layers are heated from below and the medium is allowed to cool until a steady-state temperature profile is reached at which point we calculate a spectrum by determining the brightness temperature of the medium at each wavelength.

Results: Preliminary results indicate that spectra from our modeled surfaces (for both Mars and airless bodies) show significant differences from spectra of isothermal surfaces. These differences are attributed to near-surface thermal gradients over the range of depths from which the emission is generated. Our results demonstrate the importance of calculating the effects of near-surface temperature gradients in interpreting thermal emission spectra for both Mars and the Moon.

References: [1] Wechsler, A.E., P.E. Glaser, and J.A. Fountain, in *Thermal Characteristics of the Moon*, J. Lucas, ed., MIT press, 1972. [2] Campbell, M.J. and J. Ulrichs, *J. Geophys. Res.*, **74**, 5867-5881, 1969.